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PHYSICAL CHEMISTRY OF HIGH POLYMERS - SURFACE PROPERTIES OF INTERPENETRATING POLYMER NETWORKS.

FINAL REPORT

H. L. FRISCH

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The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

We have investigated the surface chemistry of interpenetrating polymer networks (IPN) as they relate to the development of a new class of improved, thermally stable adhesives with unusual surface and adhesive properties. We have carried out mechanical, thermal, wetting, permeability and electron microscopic investigations of polyurethane epoxy and polyacrylate IPN's. We have studied the minimum critical surface tension as a function of network composition, as

20. ABSTRACT CONTINUED

observed in polyurethane-epoxy IPN's and transport properties in such homogeneous and partially inhomogeneous polymers.

Summary of Results:

We have synthesized novel classes of polyurethane-epoxy 1,2 (PU-EP) and polyurethane-acrylate 3 (PU-AC) interpenetrating polymer networks (IPN) and compared their thermal and morphological characteristics with a newly synthesized IPN composed of polystyrene and poly (2,6 - dimethyl - 1,4 phenylene oxide)(PS-PPO 2,4). The last is an ideally IPN since the component polymers form miscible blends. The domain sizes of the PU-EP IPN were not much larger than that of the PS-PPO IPN while the PU-AC showed larger domains and exhibited two inwardly shifted glass transition temperatures. The PU-EP IPN's had outstanding adhesive properties while the PU-AC IPN's are promising candidates for coatings, etc.

We have measured the advancing contact angles of drops of water methanol and methanol-ethylene glycol mixtures on films of polyurethane-epoxy interpenetrating polymer networks. The extrapolated critical surface tensions were in excellent agreement with each other. A sharp minimum is observed in the critical surface tension at network compositions where we have found maxima in ultimate mechanical properties. We advance a physical explanation based on unrelieved surface strains. We have also measured the toluene vapor transmission (permeability, diffusion and sorption coefficients) in these films. These results, together with the water vapor permeabilities, are in complete accord with the expected morphologies of these networks. A fuller discussion of how the morphological aspects and the minimum critical surface tension can be employed in adhesive technology is given in reference 5. The extent to which these characteristics ares hared by IPN's made of polymers which form compatible polymer blends is reviewed extensively in reference 3. Recently our group has been joined by Dr. H. S. Xiao of the Organic Chemistry Institute of the Chinese People's Republic who has informed us of the application of PU-EP, similar to the ones prepared by us, for an optimal anti-cavitation turbine propeller coating.

Extensive theoretical investigations have been carried out on diffusional processes which underlie some of these experimental investigations. Specifically we studied the theory of diffusion in glassy[6] and inhomogeneous[7 8 9] (phase separated) systems. Jointly with Prof. S. A. Stern we have prepared a review of selective permeation of gases through polymers[10]. We have shown how OsO_4 staining, used in our morphological investigations, affects the gas permeability of polymer films [11].

We have begun the process of computer modelling on a molecular scale of bulk polymeric systems. The preliminary results can be found in reference 12 and are in substantial agreement with predicitions of polymer scaling theories[13] . Ultimately we hope to study in this fashion the surfaces of idealized bulk polymers.

We have also investigated the basic physical processes which relate the adhesion of polymer coatings in strengthening glass fibers for optical communication [14 15].

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List of Publications and Technical Reports under Sponsorship of this Grant:

A. Technical Reports:

Progress Reports: 9/1/77 to 2/1/78; 2/1/78 to 9/1/78; 9/1/78 to 6/30/79; 7/1/79 to 1/31/80; 2/1/80 to 6/30/80.

B. Publications:

1. Barrier and Surface Properties of Polyurethane Epoxy Interpenetrating Polymer Networks I, H. L. Frisch, J. Cifaratti, R. Palma, R. Schwartz, R. Foreman, H. Yoon, D. Klempner and K. C. Frisch in Polymer Alloys (ed. by D. Klempner and K. C. Frisch), Plenum Publishing Corp., New York New York, p. 97 (1977).

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